Application for Construction and Numerical Analysis of New Melting Elements

L. Strehar, S. Kovač, D. Janc
R&D ETI Elektroelement d.o.o., Izlake, Slovenia

INTRODUCTION:

ETI is one the leading manufacturers of fuses in the world. Different standard sizes, rated currents, rated voltages and electric tripping characteristics mean over 750 different types of products. With the use of COMSOL Multiphysics® we improved the process of developing new melting elements. Entire geometry of melting element is parameterized and can be quickly build in a designated aplication created with the Application builder. One of most important parameter of a fuse is the calculated cold resistance of its melting element(s) and defines electric tripping characteristics of the fuse. In order to simulate heating during a short circuit, we can also model the melting element as a part of electric circuit.

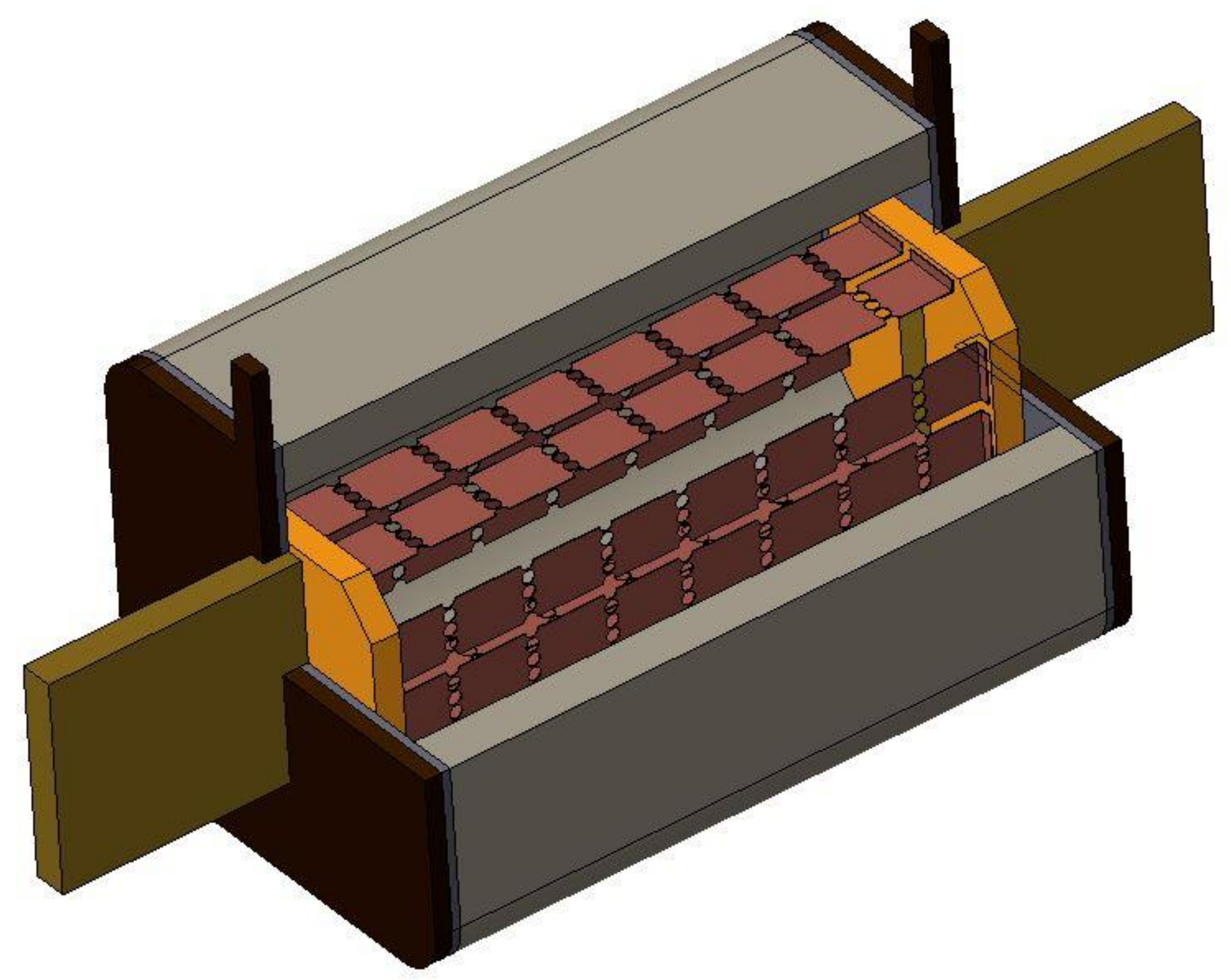

Figure 1. Fuse with multiple melting elements inside.

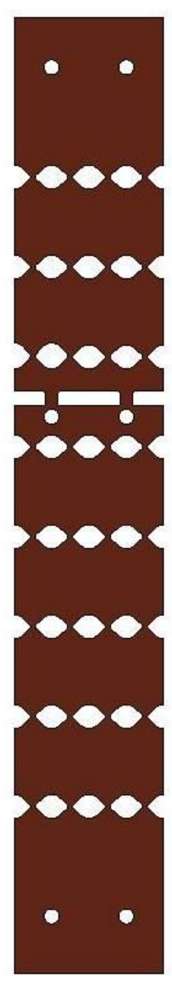

Figure 2. Example of melting element.

COMPUTATIONAL METHODS:

- *Electric Currents, Electric Circuit* and *Heat Transfer* physics are used in the model.
- Resistivity of melting element increases with temperature so the physics are coupled via *Temperature coupling*.
- Depending on the melting element 3D or 2D geometry is used in the models.

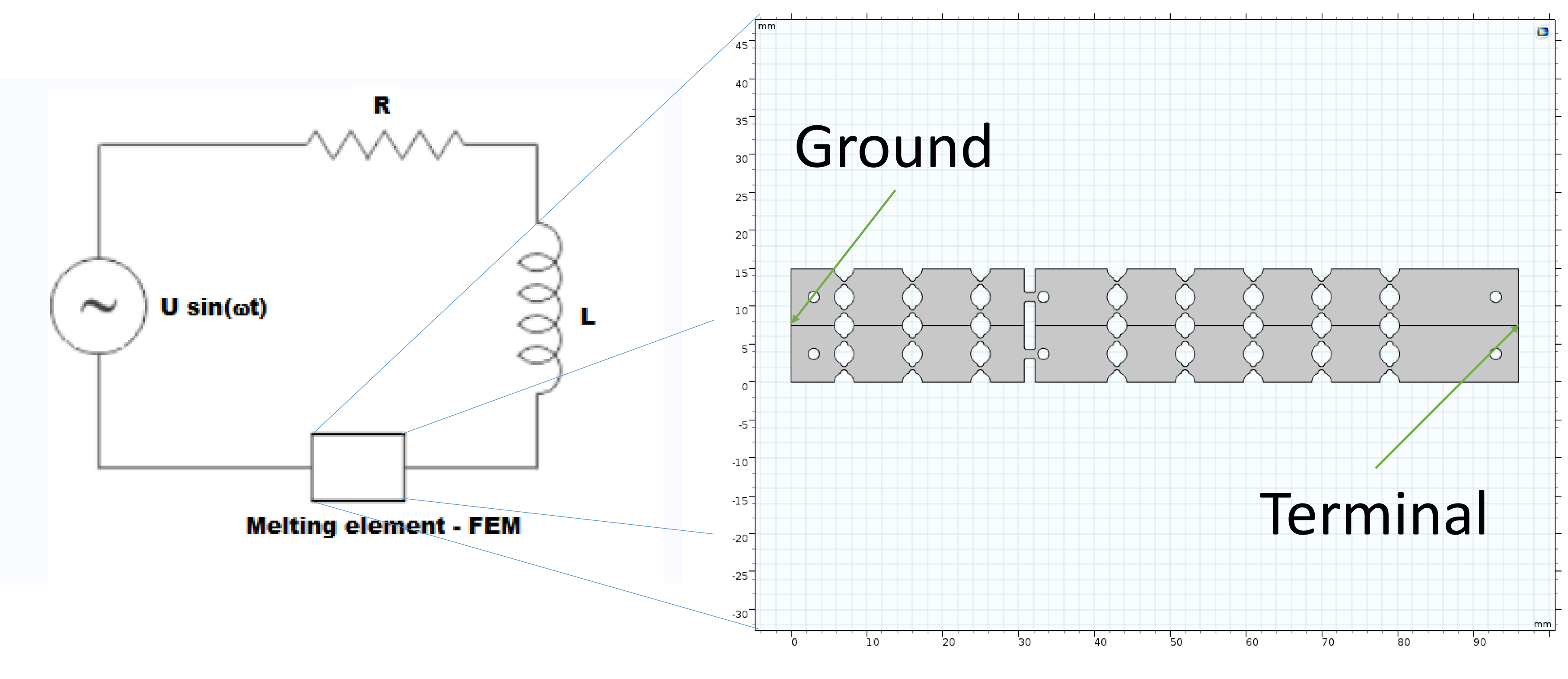

Figure 3. Electric circuit with melting element as FEA model.

RESULTS:

Figure 4 shows the user inteface of the application. On the left we have the input parameters which can be modified and a drawing of the melting element. Our new geometry is then plotted in the first window and next to it a mesh which was generated automaticly. The calulated cold resistance is shown in bold text. On the bottom two pictures we can see the voltage drop on the melting element and density of electric current at 1 A. If needed we can also add the resistivity of contacts and sum up resistances of multiple melting elements to obtain the resistivity of the entire fuse.

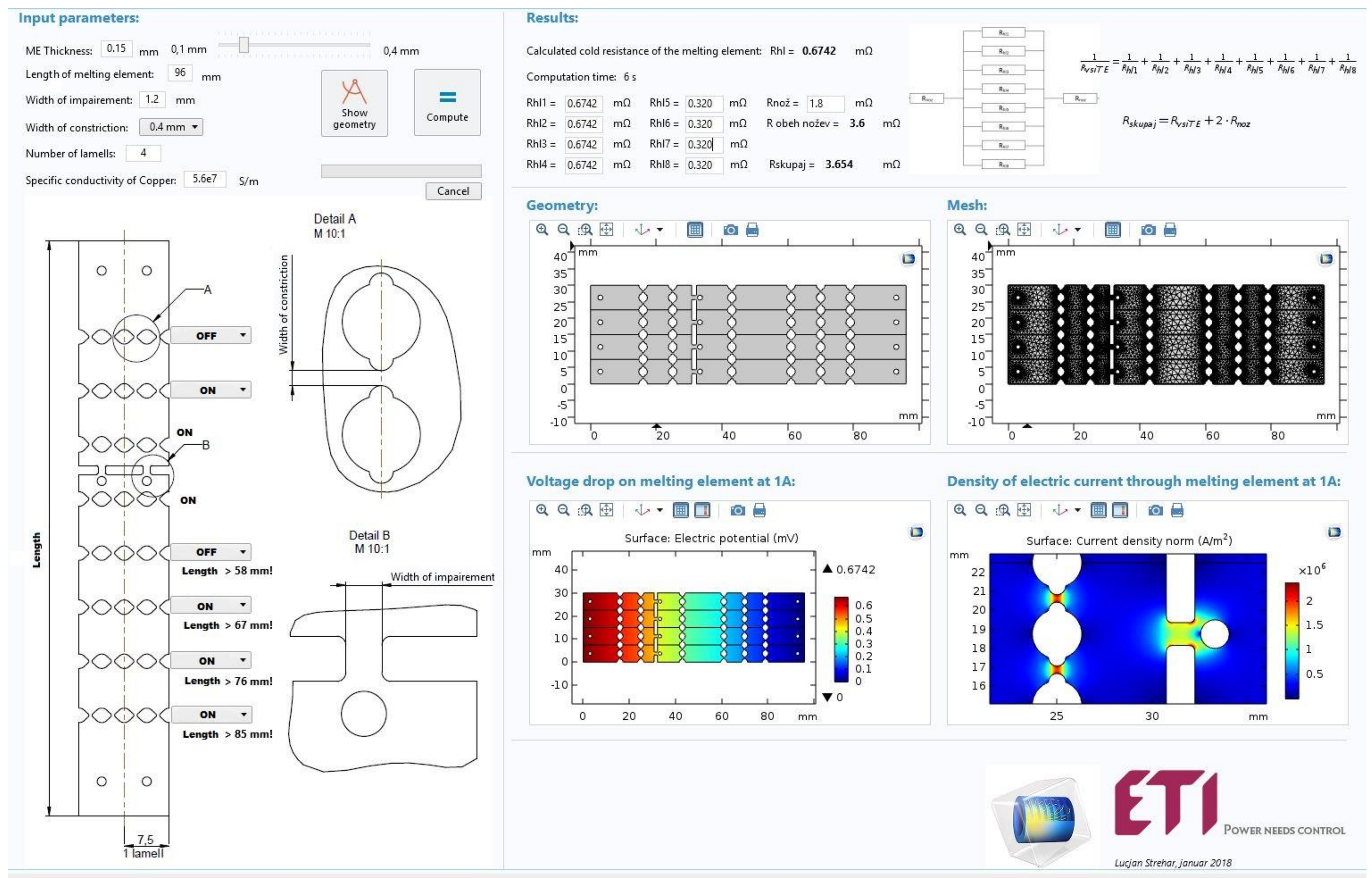

Figure 4. User interface of the application.

Figure 5 shows the calulated time when copper starts to melt and electric arc forms. The graph on the right shows the rise of electric current through the melting element during the short circuit.

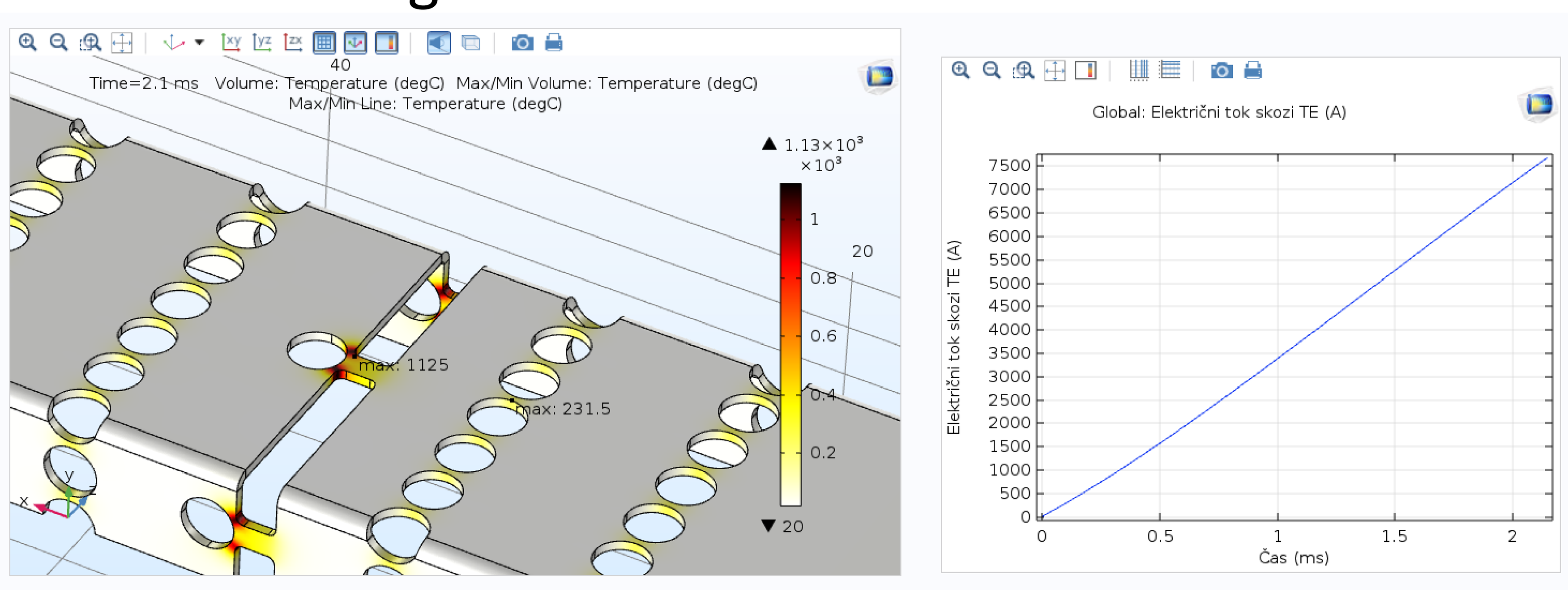

Figure 5. Exact moment when copper starts to melt and electric arc forms.

CONCLUSIONS:

- COMSOL Multiphysics® can be used both for designing the geometry of new melting elements as for its numerical analysis.
- The calculated values were proven to be accurate in real life application.
- With the use of COMSOL Multiphysics® we need less time to develop new melting elements plus the entire process is more cost effective.
- Application can be used as a part of DFMEA (Design Failure Mode and Effect Analysis).

Excerpt from the Proceedings of the 2018 COMSOL Conference in Lausanne